DOI:
10.1016/j.jash.2017.04.013

Document Version
Peer reviewed version

Accepted Manuscript

Prevalence, Awareness, Treatment and Control of Hypertension in Older People in Central Africa: The Epidemca Study

Sophie Pilleron, Victor Aboyans, Pascal Mbelesso, Bébène Ndamba-Bandzouzi, Ileana Desormais, Philippe Lacroix, Pierre-Marie Preux, Maëlenn Guerchet, Maëlenn Guerchet, Bébène Ndamba-Bandzouzi, Pascal Mbelesso, Sophie Pilleron, Iléana Desormais, Philippe Lacroix, Victor Aboyans, Jean-Claude Desport, Pierre Jésus, Achille E. Tchalla, Benoît Marin, Jean-Pierre Clément, Jean-Charles Lambert, Jean-François Dartigues, Pierre-Marie Preux

PII: S1933-1711(17)30148-1

DOI: 10.1016/j.jash.2017.04.013

Reference: JASH 1033

To appear in: *Journal of the American Society of Hypertension*

Received Date: 10 February 2017

Revised Date: 6 April 2017

Accepted Date: 26 April 2017

Please cite this article as: Pilleron S, Aboyans V, Mbelesso P, Ndamba-Bandzouzi B, Desormais I, Lacroix P, Preux P-M, Guerchet M, for the EPIDEMCA group, Guerchet M, Ndamba-Bandzouzi B, Mbelesso P, Pilleron S, Desormais I, Lacroix P, Aboyans V, Desport J-C, Jésus P, Tchalla AE, Marin B, Clément J-P, Lambert J-C, Dartigues J-F, Preux P-M, Prevalence, Awareness, Treatment and Control of Hypertension in Older People in Central Africa: The Epidemca Study, *Journal of the American Society of Hypertension* (2017), doi: 10.1016/j.jash.2017.04.013.

PREVALENCE, AWARENESS, TREATMENT AND CONTROL OF HYPERTENSION IN OLDER PEOPLE IN CENTRAL AFRICA: THE EPIDEMCA STUDY

Sophie Pilleron[1,2], Victor Aboyans[1,2,3], Pascal Mbelesso[4], Bébène Ndamba-Bandzouzi[5], Ileana Desormais[1,2,3], Philippe Lacroix[1,2,3], Pierre-Marie Preux[1,2,6], Maëlenn Guerchet[1,2,7] for the EPIDEMCA group (Maëlenn Guerchet, Bébène Ndamba-Bandzouzi, Pascal Mbelesso, Sophie Pilleron, Iléana Desormais, Philippe Lacroix, Victor Aboyans, Jean-Claude Desport, Pierre Jésus, Achille E. Tchalla, Benoît Marin, Jean-Pierre Clément, Jean-Charles Lambert, Jean-François Dartigues and Pierre-Marie Preux)

[1]INSERM, UMR 1094, Tropical Neuroepidemiology, Limoges, France, [2]University of Limoges, UMR 1094, Tropical Neuroepidemiology, Institute of Neuroepidemiology and Tropical Neurology, CNRS FR 3503 GEIST, Limoges, France, [3]CHU Limoges, Department of Cardiology, Limoges, France, [4]Amitié Hospital, Department of Neurology, Bangui, Central African Republic, [5]CHU Brazzaville, Department of Neurology, Brazzaville, Republic of Congo, [6]CHU Limoges, Centre of Epidemiology, Biostatistic, and Research Methodology, CEBIMER, Limoges, France, [7]King's College London, Centre for Global Mental Health, Institute of Psychiatry, Psychology and Neuroscience, Health Service and Population Research Department, London, UK

Correspondence: Sophie Pilleron, UMR INSERM 1094 NET, 2 rue du Docteur Marcland, 87025 Limoges cedex, France; sophie_pilleron@hotmail.com

Abstract

Hypertension represents a major global health burden. While older individuals of African descent are at higher risk of hypertension in western countries, epidemiological data on hypertension in older native Africans are scarce. We assessed the prevalence and the level of awareness and control of hypertension among older adults in Central Africa. A total of 1990 individuals 65 years of age and older from the Republic of Congo and the Central African Republic participated into a cross-sectional population-based survey. Hypertension was defined by self-reporting of on-going treatment and/or systolic (SBP)/diastolic (DBP) blood pressures at rest being ≥140 and/or 90 mmHg. Controlled hypertension was defined as treated hypertension with SBP <140 mmHg and DBP <90 mmHg. The overall prevalence of hypertension was 61.1%. Among hypertensive people, 46.7% were aware of their condition and 17.3% were treated. Among the latter 23.8% had their hypertension controlled. Correlates of hypertension were increasing age and body mass index, living in the Republic of Congo, occupation other than employee, no tobacco use, sedentary lifestyle and ≥ 3 meals a day. Our findings indicate a need for the implementation of public health policies to reduce hypertension in older Africans, and to prevent the subsequent burden of cardiovascular diseases.

Keywords: Hypertension, epidemiology, elderly, Central Africa

According to the United Nations, the number of persons 65 years of age and older is expected to more than double by 2035, from 608 million in 2015 to 1.2 billion in 2035 [1]. Almost a quarter (23%) of the total global burden of disease is attributable to disorders in people aged 60 years of age and older, among whom cardiovascular diseases (CVDs) are the leading contributors to the burden of disease. Among CVDs, hypertension is the leading cause of mortality and morbidity [2]. one of the global non-communicable disease targets of the World Health Organization is to lower the prevalence of raised blood pressure by 25% by 2025 [4]. However, a global increase in the prevalence of hypertension in low-income countries is now being observed, notably in Sub-Saharan Africa [3].

In the United States, the prevalence of hypertension is more than 60% among older people and is higher in older African-Americans when compared to non-Hispanic whites [5]. Ethnic differences cannot be explained solely in terms of socio-economic status [5], suggesting the involvement of other factors. It is therefore important to know more about the epidemiology of hypertension in older native Africans.

Several community-based epidemiological studies on hypertension were conducted in Africa [6]. Most were carried out in adults and reported prevalence for the ≥65 age group [7–19]. Only one study in rural Tanzania was specifically conducted on the elderly and reported a prevalence of hypertension of 70% in people over 70 years of age [17]. To our knowledge, no data from older populations in Central Africa are still available.

We thus aimed at estimating the prevalence of hypertension among elderly people from urban and rural areas in the Central African Republic and the Republic of Congo. Factors associated with hypertension, awareness of hypertension, and control of hypertension were also examined.

METHODS

Study population

Our study population consisted of participants in the EPIDEMCA (Epidemiology of Dementia in Central Africa) program, a multicentre population-based cross-sectional survey among adults aged 65 years of age and older in rural and urban areas in the Central African Republic and the Republic of Congo which was conducted between November 2011 and December 2012. Its main objective was to

assess the prevalence of dementia and to investigate risk factors. Exclusion criteria were refusals and the presence of severe comorbidities which precluded an interview and/or cognitive testing. The study areas included the capitals of the Central African Republic (Bangui) and the Republic of Congo (Brazzaville), and two rural regions (Nola in the Central African Republic and Gamboma in the Republic of Congo). The sample size was estimated *a priori* at 500 in each study site. In urban areas, the participants' selection was carried out stratified by city subdivision, with individuals sampled randomly proportional to the population. In rural areas, exhaustive sampling using a door-to-door approach was used due to logistic and financial constraints. The detailed methodology is described in an open-access publication [20].

Ethics

Ethical approval was obtained from the ethical committee supervised by the Ministry of Public Health in the Central African Republic, the *Comité d'Éthique de la Recherche en Sciences de Santé* in the Republic of Congo, and the *Comité de Protection des Personnes du Sud-Ouest et d'Outre-Mer 4* in France. All participants and/or their families gave informed consent prior to inclusion in the study. Written consent was obtained where feasible. For people who were illiterate, the study's objectives were verbally explained and consent was obtained by thumbprint.

Hypertension definition

Systolic and diastolic resting blood pressures were recorded twice for each arm at 5-minutes intervals with the participant in a supine position, using a standard mercury sphygmomanometer. The average of the four measurements was used in the analyses. Hypertension was defined by self-reporting of on-going treatment or systolic blood pressure (SBP) at rest ≥140 mmHg and/or diastolic blood pressure (DBP) at rest ≥90 mmHg [21]. Controlled hypertension was defined as treated hypertension with SBP <140mmHg and DBP <90 mmHg. Participants were considered aware of their hypertension if they were hypertensive and responded positively to the following question: "Have you ever been told that you had hypertension?"

Other data

Socio-demographic data included age, sex, marital status (never married, living with someone as a couple, widow, divorced/separated), primary education (yes/no), previous occupation

(employee/government employee, craftsman/storekeeper, farmer/breeder/fisherman), country (Central African Republic, Republic of Congo) and area (urban, rural). Age was ascertained from official documents, by using historical events [22], or from an informant.

Tobacco use was assessed, and participants were classified as never smokers, past smokers, current smokers (including cigarette, cigar and pipe), or partaking in other modes of tobacco use (snuff, chewing tobacco, intrarectal use). Participants were physically active if they walked or cycled at least 150 minutes the previous week. Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared and rounded to 1 decimal place. Weight was measured to the nearest 100g on mechanical scales with a weighing capacity of 10 to 150 kg (Seca®, Hamburg, Germany). Height was measured to the nearest centimetre using a carpenter meter along a surface as flat as possible, such as a door or wall. If height could not be measured because the participant could not stand upright, height was evaluated using the knee height (KH). KH was measured to the nearest centimetre on the right leg with the participant in a supine position using Chumlea's formula for non-Hispanic Black people as follows: height (cm) = 79.69+(1.85*KH (cm))-(0.14*age (year)) for men and height (cm) = 89.58+(1.61*KH (cm))-(0.17*age (year)) for women [23]. Cholesterol was measured from plasma aliquots in the Biochemistry department of the Limoges University Hospital using standard procedures. Hypercholesterolemia was defined as being above 5.3 mmol/L. Diabetes was defined as currently taking antidiabetic drugs or having a fasting glycaemia ≥126 mg/dl or 2-h plasma glucose ≥200 mg/dl in non-fasting participants [24].

Nutritional variables consisted of the daily number of meals (categorized in 1, 2 or 3 meals or more) and several anthropometric measurements used as proxies for fat mass. The triceps skinfold thickness (TST) was measured three times to the nearest 0.2 mm on the right arm according to Lohman standard procedures with an Harpenden calliper [25]. The average of the three measures was used in the calculation. The mid-upper arm circumference (MUAC) was measured on the right arm to the nearest 1 mm with a non-stretch tape at a level midway between acromion and olecranon. Abdominal obesity was defined as a waist-hip ratio (WHR) above 0.90 for males and 0.85 for females [26]. Alcohol consumption was assessed using the following question: "How many doses of alcohol do you drink in a normal week?" One dose of beer was assumed to be 33 cl; liquor 25 ml, and local drinks 500 ml.

From these data, we generated the number of units of alcohol (UA) consumed in a normal week (1 UA = 10 g). Alcohol consumption was then categorized as abstainers (0 UA/week consumed in a normal week); light consumers (0-14 UA/week for females and 0-21UA/week for males) and moderate-to-heavy consumers ($\geq$14 UA/week for females and $\geq$21UA/week for males).

Data analysis

We first described sample characteristics, reporting the prevalence and corresponding 95% confidence intervals (CIs). Because of their non-normal distribution, quantitative variables (age, BMI, SBP and DBP) were categorized using median and interquartile ranges. Comparisons were carried out using the Chi-square test for categorical variables or Kruskal-Wallis test for continuous variables. The Cochran-Armitage Trend Test was used to test for trends.

Factors associated with hypertension were determined using logistic regression models. For description purposes, we computed unadjusted odds ratios (OR). The associations were then adjusted for socio-demographic factors: age, sex, country, area, marital status and previous occupation (model 1). Cardiovascular risk factors - *i.e.* tobacco use, BMI, physical activity, hypercholesterolemia and diabetes were additionally adjusted for the second model (model 2). In the third model (model 3), nutritional factors (*i.e.* the number of daily meals and alcohol consumption) were also adjusted for. Age and BMI were used as continuous variables because the linearity hypothesis could not be rejected. In complementary analyses, we replaced BMI successively by MUAC, TST and abdominal obesity. MUAC and TST were included as continuous variables as the log-linearity could not be rejected. We used the natural logarithm of MUAC to verify the assumption of log-linearity. The level of significance was fixed at 0.05 for all analyses. Statistical analyses was carried out using Stata version 10.1 for Windows (StataCorp, College Station, TX).

RESULTS

Study population

Of the 2113 subjects 65 years of age and older who were approached, 111 declined to participate in the EPIDEMCA study, and data for hypertension were missing for 12 participants, resulting in a total

sample size of 1990 participants (response rate = 94.2%).

Prevalence of hypertension

The overall prevalence of hypertension was 61.1% (95%CI: 58.9-63.2), with the prevalence of hypertension being higher in the Republic of Congo (68.0%) compared to the Central African Republic (53.7% - p<0.001) (Table 1). When stratified by study location, the prevalence of hypertension was significantly higher in urban areas than in rural areas (58.4% vs 48.6%; p=0.002) in the Central African Republic, while this comparison was not significant in the Republic of Congo (p=0.057) (Figure 1). The prevalence of hypertension was also higher in women than in men (63.9% vs. 56.5%; p=0.001). Furthermore, the prevalence of hypertension increased significantly with age in the Central African Republic (p-trend=0.010) but not in the Republic of Congo (p-trend=0.083) (Figure 2).

Factors associated with hypertension

The univariate analysis indicated that increasing age, female sex, increasing, living in the Republic of Congo, living in an urban area, being widowed, previous occupation other than employee, increasing BMI, hypercholesterolemia, eating more than one meal a day were associated with an increased likelihood of hypertension (Table 2). The past or current use of tobacco and physical activity were associated with a lower likelihood of hypertension. In the full model (model 3), increasing age, living in the Republic of Congo, occupation, increasing BMI and eating more than one meal a day remained significantly associated with an increased likelihood of hypertension, while the past or current use of tobacco and physical activity remained associated with a lower probability (Table 2). Complementary analyses showed a higher likelihood of hypertension in the case of obesity when using alternate proxies of fat mass (Table 3).

Prevalence of awareness, treatment and control

Among hypertensive participants, 46.9% (95% CI: 44.1-49.7) were aware of their hypertension (Figure 3). Awareness did not differ between men and women (43.6% vs. 48.7%; p=0.094), decreased with age (p-trend = 0.008), was lower in the Central African Republic compared to the Republic of Congo (34.5% vs. 56.1%; p<0.001), and was lower in rural compared to urban areas (42.6% vs. 50.7%; p=0.005). All these associations remained significant in the multivariate analysis (Table 4).

Only 17.3% (95% CI: 15.2-19.4) of hypertensive participants indicated receiving anti-hypertensive treatment at the time of the study (Figure 3). No difference in the prevalence of treatment was observed between men and women (p=0.107); however, the prevalence of people receiving treatment decreased with age (p-trend=0.014), was lower in the Central African Republic compared to the Republic of Congo (8.3% vs. 24.0%; p<0.001) and was lower in rural areas compared to urban areas (12.6% vs. 21.4%; p<0.001). These associations persisted in the multivariate analysis (Table 4).

Of the participants treated for hypertension, less than a quarter (23.8%, 95% CI: 17.9-29.6) had their blood pressure controlled (4.1%, 95% CI: 2.9-5.2, of the total hypertensive participants) (Figure 3). This percentage decreased with age (p-trend=0.006), but did not differ significantly between sexes (p=0.315), country (p=0.419), or urban and rural areas (p=0.157). The same results were observed in the multivariate analysis (Table 4).

DISCUSSION

To our knowledge, this large population-based study is the first investigation of the prevalence and associated factors of hypertension in the elderly in Central Africa. As hypothesized, hypertension is highly prevalent in elderly populations (61%).

Epidemiological data on hypertension in the elderly in Africa are still scarce. We found only one study specifically conducted in elderly people over the age of 70, reporting a prevalence of 70% in rural Tanzania [17]. Other studies reported the prevalence of hypertension in people aged 65 and over [7–19], ranging from 34.5% in urban Kenya [15] to 88.0% in urban Senegal [13].

The disparity in prevalence between the Republic of Congo (68.0%) and the Central African Republic (53.7%), two neighbouring countries, may be related, in part, to differences in socio-economic levels, as the Republic of Congo is a wealthier country. Indeed, according to the World Bank, 46.5% of inhabitants of the Republic of Congo (in 2011) were living under the poverty line vs. 62.0% in the Central African Republic (in 2008). Furthermore, in 2012, the Gross National Income was 2480 USD *per capita* in the Republic of Congo vs. 490 USD in Central African Republic. We also found a lower prevalence of hypertension in rural areas compared to urban areas, which was non-significant after adjustment for vascular risk factors; however, the traditional rural-urban gradient observed in several

African studies [27–29] has been decreasing over the last 20 years [6].

Our results confirm some previously observed associations, such as increasing age [6,30], sedentary lifestyle [31], and BMI [32] being associated with an increased prevalence of hypertension. The association between obesity and hypertension may differ according to fat distribution, with visceral fat more strongly associated with hypertension when compared to subcutaneous adipose [32]; however, an association between peripheral fat mass (as measured using WHR) as well as abdominal fat mass (as measured using TCT) and the prevalence of hypertension were both observed.

Unexpectedly, this study observed that tobacco users, usually found as at higher risk of CVD [33], were less likely to be hypertensive. This result was also observed in one study conducted in adults in Turkey [34], but direct comparisons are difficult as settings are different. This finding may be explained by selection bias due to premature death of hypertensive smokers, as the current study was carried out among older adults far beyond the average life expectancy in the studied countries; however, further investigation is required.

In our study, alcohol consumption was not significantly associated with hypertension, although it is a well-known risk factor [35]. The results from sub-Saharan African studies on the risk relationship between alcohol consumption and hypertension are mixed; some studies, primarily in South Africa, observed an association [36], while other studies emanating from other sub-Saharan African countries observed no significant association [37]. All these studies are hardly comparable since the setting, the assessment mode of alcohol consumption assessment age at inclusion are different. As with tobacco use, a survival bias could in part also explain this lack of an association between alcohol and hypertension.

We also found no significant association between high cholesterol and hypertension. The prevalence of hypercholesterolemia in our sample (around 10%) is low compared to studies from Western countries, although African populations have been observed to have lower total cholesterol levels than do Caucasians [28,38,39]. Accordingly, some researchers have suggested specific thresholds for the definition of hypercholesterolemia in African populations [39]. The lack of data on cholesterol subtypes due to logistic constraints is a limitation of our study.

The consumption of three or more meals daily was associated with a higher likelihood of

hypertension, even when adjusted for obesity and physical activity. This observation may be due, in part, to the consumption of three or more meals per day being correlated with socio-economic status and, thus, a resulting increase in the intake of salt and fat which are both important risk factors for hypertension [40].

In our study, only less than one-half of hypertensive participants were aware of their condition. Only one-fifth took antihypertensive treatments, and among them, less than one-quarter had their hypertension controlled. Few studies have reported awareness of hypertension, treatment of hypertension and controlled hypertension in older adults in Africa. Firstly, among 1553 hypertensive individuals 70 years of age and older in rural Tanzania, 37.1% were aware of their condition, 6.1% of the total sample were treated for hypertension, and less than 1% had controlled hypertension [17]. Secondly, a study in Kenya observed that 29.1% of hypertensive individuals 60 years of age and older were aware of their condition, 56.6% of individuals aware of their condition were treated for hypertension and 21.6% of treated hypertensives had their hypertension controlled [41]. Lastly, a study of adults 65 years of age and older in rural and urban areas of Uganda found that 38.0% of adults were aware of their hypertension [18]. The prevalences of those who were aware of their hypertension and those with controlled hypertension were higher in this study when compared to other studies from sub-Saharan Africa. An explanation for these differences could be variances in socio-economic levels and in access to health care between countries. Despite differences between countries and studies, the findings of this study, in combination with other studies' findings, suggest the need to improve awareness and access to health services for the screening and treatment of hypertension in Central Africa.

The current study has several limitations. The definition of hypertension is based on two sets of measurements taken in a 15-minute interval in a single visit. No ambulatory pressures were available. We cannot exclude the possibility of a white coat effect. Furthermore, blood pressure was measured with the participants in the supine position, a method that yields lower blood pressure values than would be observed if participants were than in the recommended sitting position, especially for DBP readings. [42]. This may thus underestimate the prevalence of hypertension in our study. However, participants were asked to lie down to facilitate a number of other measurements, including ankle-

brachial index to detect peripheral artery disease (the results are reported elsewhere [43]). Due to the cross-sectional design of the study, the temporal nature of the associations could not be assessed, and selection bias by survival cannot be totally excluded. We also cannot exclude the existence of recall bias, especially for nutritional factors but we believe it is limited since informants were interviewed alongside participants, and we cannot expect any systematic bias regarding their association with hypertension. Furthermore, data on salt intake were not available, and thus were not adjusted for in this study.

In terms of public health, our findings highlight the urgent need for hypertension screening, treatment and control in elderly African populations to limit or prevent the expected huge CVD burden, as such populations will grow substantially in the near future. Furthermore, older individuals are not yet targeted by health programs in sub-Saharan Africa, as the focus of health priorities is on children, childbearing women, and people living with HIV/AIDS [44]. Moreover, primary healthcare systems are not prepared to the extent required to properly manage older adults who often present with several comorbidities.

CONCLUSIONS

This large multicentre study confirms the high prevalence, low awareness and low control of hypertension in older men and women in Sub-Saharan Africa, with disparities in different countries and areas related to the different distribution of CVD risk factors and to differences in socio-economic levels. Due to the combination of an aging population and the westernization of the lifestyle (fat- and salt-rich diets and sedentary lifestyles), major public health interventions are warranted in these countries. The present results highlight the need for blood pressure monitoring in older adults in Africa, a population which will grow substantially in the next few decades. Decreasing blood pressure at a population level, particularly in older adults, is required to curb the predicted escalating increase of CVD events [40].

ACKNOWLEDGEMENTS

The authors would like to thank for their assistance the participants in the EPIDEMCA study, as well as the students and nurses who were involved. The authors also thank town hall staff, mayors, and chiefs of districts for their collaboration, and the University of Bangui (in Bangui, Central African Republic), Marien Ngouabi University (in Brazzaville, Republic of Congo), and the Health ministries of the Central African Republic and the Republic of Congo for their support. Lastly, the authors thank Dr Kevin D. Shield for editing this manuscript.

The French National Agency (ANR) funded this study through the ANR-09-MNPS-009-01 grant. The University of Limoges, Doctoral School 523 of Limoges University, the Limousin Regional Council, and the French Ministry of Higher Education and Research funded the doctoral position of S. Pilleron.

DISCLOSURES: The authors declare there are no conflicts of interest.

References

1. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2015 Revision. 2015 [cited 2016 Sep 12]. Available from: https://esa.un.org/unpd/wpp/

2. Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R, et al. The burden of disease in older people and implications for health policy and practice. 2015;385:549-62.

3. WHO. Global action plan for the prevention and control of noncommunicable diseases 2013–2020. WHO. [cited 2017 Jan 31]. Available from: http://www.who.int/en/

4. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. Lancet Lond Engl. 2017;389:37–55.

5. Delgado J, Jacobs EA, Lackland DT, Evans DA, de Leon CFM. Differences in blood pressure control in a large population-based sample of older African Americans and non-Hispanic whites. J Gerontol A Biol Sci Med Sci. 2012;67:1253–8.

6. Adeloye D, Basquill C. Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis. PloS One. 2014;9:e104300

7. Cappuccio FP, Micah FB, Emmett L, Kerry SM, Antwi S, Martin-Peprah R, et al. Prevalence, detection, management, and control of hypertension in Ashanti, West Africa. Hypertens Dallas Tex 1979. 2004;43:1017–22.

8. Longo-Mbenza B, Ngoma DV, Nahimana D, Mayuku DM, Fuele SM, Ekwanzala F, et al. Screen detection and the WHO stepwise approach to the prevalence and risk factors of arterial hypertension in Kinshasa. Eur J Cardiovasc Prev Rehabil. 2008;15:503–8.

9. Wamala JF, Karyabakabo Z, Ndungutse D, Guwatudde D. Prevalence factors associated with hypertension in Rukungiri district, Uganda--a community-based study. Afr Health Sci. 2009;9:153–60.

10. Maher D, Waswa L, Baisley K, Karabarinde A, Unwin N. Epidemiology of hypertension in low-income countries: a cross-sectional population-based survey in rural Uganda. J Hypertens. 2011;29:1061–8.

11. Yayehd K, Damorou F, Akakpo R, Tchérou T, N'Da NW, Pessinaba S, et al. [Prevalence and determinants of hypertension in Lomé (Togo): results of a screening in May 2011]. Ann Cardiol Angeiol. 2013;62:43–50.

12. Peltzer K, Phaswana-Mafuya N. Hypertension and associated factors in older adults in South

Africa. Cardiovasc J Afr. 2013;24:67–71.

13. Pessinaba S, Mbaye A, Yabeta G-A-D, Kane A, Ndao CT, Ndiaye MB, et al. Prevalence and determinants of hypertension and associated cardiovascular risk factors: data from a population-based, cross-sectional survey in Saint Louis, Senegal. Cardiovasc J Afr. 2013;24:180–3.

14. Doulougou B, Kouanda S, Rossier C, Soura A, Zunzunegui MV. Differences in hypertension between informal and formal areas of Ouagadougou, a sub-Saharan African city. BMC Public Health. 2014;14:893

15. Joshi MD, Ayah R, Njau EK, Wanjiru R, Kayima JK, Njeru EK, et al. Prevalence of hypertension and associated cardiovascular risk factors in an urban slum in Nairobi, Kenya: A population-based survey. BMC Public Health. 2014;14:1177

16. Steyn K, Gaziano TA, Bradshaw D, Laubscher R, Fourie J, South African Demographic and Health Coordinating Team. Hypertension in South African adults: results from the Demographic and Health Survey, 1998. J Hypertens. 2001;19:1717–25.

17. Dewhurst MJ, Dewhurst F, Gray WK, Chaote P, Orega GP, Walker RW. The high prevalence of hypertension in rural-dwelling Tanzanian older adults and the disparity between detection, treatment and control: a rule of sixths? J Hum Hypertens. 2013;27:374–80.

18. Musinguzi G, Nuwaha F. Prevalence, awareness and control of hypertension in Uganda. PloS One. 2013;8:e62236.

19. Kamadjeu RM, Edwards R, Atanga JS, Unwin N, Kiawi EC, Mbanya J-C. Prevalence, awareness and management of hypertension in Cameroon: findings of the 2003 Cameroon Burden of Diabetes Baseline Survey. J Hum Hypertens. 2006;20:91–2.

20. Guerchet M, Mbelesso P, Ndamba-Bandzouzi B, Pilleron S, Desormais I, Lacroix P, et al. Epidemiology of dementia in Central Africa (EPIDEMCA): protocol for a multicentre population-based study in rural and urban areas of the Central African Republic and the Republic of Congo. SpringerPlus. 2014;3:338.

21. World Health Organisation. A global brief on hypertension. Silent killer, global public health crisis. WHO/DCO/WHD/2013.2. 2013.

22. Paraïso MN, Houinato D, Guerchet M, Aguèh V, Nubukpo P, Preux P-M, et al. Validation of the use of historical events to estimate the age of subjects aged 65 years and over in Cotonou (Benin). Neuroepidemiology. 2010;35:12–6.

23. Chumlea WC, Guo SS, Wholihan K, Cockram D, Kuczmarski RJ, Johnson CL. Stature prediction equations for elderly non-Hispanic white, non-Hispanic black, and Mexican-American persons developed from NHANES III data. J Am Diet Assoc. 1998;98:137–42.

24. World Health Organization. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia : report of a WHO/IDF consultation. 2006.

25. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Human Kinetics Publishers; 1988. 184 p.

26. World Health Organisation. Waist circumference and waist-hip ratio: Report of a WHO Expert Consultation . Geneva: WHO; 2008 [cited 2014 Dec 2]. Available from: http://apps.who.int/iris/bitstream/10665/44583/1/9789241501491_eng.pdf

27. Kaufman JS, Owoaje EE, James SA, Rotimi CN, Cooper RS. Determinants of Hypertension in West Africa: Contribution of Anthropometric and Dietary Factors to Urban-Rural and Socioeconomic Gradients. Am J Epidemiol. 1996;143:1203–18.

28. Seedat YK, Seedat MA, Hackland DB. Prevalence of hypertension in the urban and rural Zulu. J Epidemiol Community Health. 1982;36:256–61.

29. Simmons D, Barbour G, Congleton J, Levy J, Meacher P, Saul H, et al. Blood pressure and salt intake in Malawi: an urban rural study. J Epidemiol Community Health. 1986;40:188–92.

30. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP. Burden of Undiagnosed Hypertension in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. Hypertension. 2015;65:291-8.

31. Myers J, McAuley P, Lavie CJ, Despres J-P, Arena R, Kokkinos P. Physical activity and cardiorespiratory fitness as major markers of cardiovascular risk: their independent and interwoven importance to health status. Prog Cardiovasc Dis. 2015;57:306–14.

32. Vaněčková I, Maletínská L, Behuliak M, Nagelová V, Zicha J, Kuneš J. Obesity-related hypertension: possible pathophysiological mechanisms. J Endocrinol. 2014 1;223:R63–78.

33. Messner B, Bernhard D. Smoking and cardiovascular disease: mechanisms of endothelial dysfunction and early atherogenesis. Arterioscler Thromb Vasc Biol. 2014;34:509–15.

34. Onat A, Uğur M, Hergenç G, Can G, Ordu S, Dursunoğlu D. Lifestyle and metabolic determinants of incident hypertension, with special reference to cigarette smoking: a longitudinal population-based study. Am J Hypertens. 2009;22:156–62.

35. Briasoulis A, Agarwal V, Messerli FH. Alcohol consumption and the risk of hypertension in men and women: a systematic review and meta-analysis. J Clin Hypertens. 2012;14:792–8.

36. Zatu MC, Van Rooyen JM, Kruger A, Schutte AE. Alcohol intake, hypertension development and mortality in black South Africans. Eur J Prev Cardiol. 2016;23:308–15.

37. Chin JH, Twinobuhungiro A, Sandhu A, Hootsmans N, Kayima J, Kalyesubula R.

Determinants of Raised Blood Pressure in Urban Uganda: A Community-Based Case-Control Study. Ethn Dis. 2017;27:15–20.

38. Oosthuizen W, Vorster HH, Kruger A, Venter CS, Kruger HS, de Ridder JH. Impact of urbanisation on serum lipid profiles--the THUSA survey. South Afr Med J. 2002;92:723–8.

39. Schutte AE, Schutte R, Huisman HW, Rooyen JM van, Malan L, Olckers A, et al. Classifying Africans with the metabolic syndrome. Horm Metab Res. 2009;41:79–85.

40. Sookram C, Munodawafa D, Phori PM, Varenne B, Alisalad A. WHO's supported interventions on salt intake reduction in the sub-Saharan Africa region. Cardiovasc Diagn Ther. 2015;5:186–90.

41. van de Vijver SJM, Oti SO, Agyemang C, Gomez GB, Kyobutungi C. Prevalence, awareness, treatment and control of hypertension among slum dwellers in Nairobi, Kenya. J Hypertens. 2013;31:1018–24.

42. Netea RT, Smits P, Lenders JW, Thien T. Does it matter whether blood pressure measurements are taken with subjects sitting or supine? J Hypertens. 1998;16:263–8.

43. Desormais I, Aboyans V, Guerchet M, Ndamba-Bandzouzi B, Mbelesso P, Dantoine T, et al. Prevalence of peripheral artery disease in the elderly population in urban and rural areas of Central Africa: the EPIDEMCA study. Eur J Prev Cardiol. 2015;22:1462–72.

44. Kimokoti RW, Hamer DH. Nutrition, health, and aging in sub-Saharan Africa. Nutr Rev. 2008;66:611–23.

Figure's caption

Figure 1. Prevalence of hypertension, stratified by study site, EPIDEMCA, 2011-2012

Figure 2. Prevalence of hypertension, stratified by age and country, EPIDEMCA, 2011-2012

Figure 3. Venn diagrams representing the prevalences of hypertension, treated hypertension, and controlled hypertension in the total population and in each study site, EPIDEMCA 2011-2012

Table 1. Characteristics of EPIDEMCA participants, 2011-2012

	Central African Republic (CAR)					Republic of Congo (ROC)				
	Total population	**Total**	**Rural area**	**Urban area**	**p Rural vs Urban**	**Total**	**Rural area**	**Urban area**	**p Rural vs Urban**	**p C vs RO**
Total sample size	1990	967	469	498		1023	525	498		
Sociodemographic variables										
Age (years old), n (%)					0.683				0.897	**0.0**
65-69	723 (36.3)	383 (39.6)	183 (39.0)	200 (40.2)		340 (33.2)	171 (32.6)	169 (33.9)		
70-74	514 (25.8)	250 (25.9)	120 (25.6)	130 (26.1)		264 (25.8)	137 (26.1)	127 (25.5)		
75-79	374 (18.8)	169 (17.5)	89 (19.0)	80 (16.1)		205 (20.0)	103 (19.6)	102 (20.5)		
80+	379 (19.1)	165 (17.1)	77 (16.4)	88 (17.7)		214 (20.9)	114 (21.7)	100 (20.1)		
Females, n (%)	1224 (61.5)	601 (62.2)	277 (59.1)	324 (65.1)	0.055	623 (60.9)	320 (61.0)	303 (60.8)	0.972	0.5
Marital status, n (%)					0.619				**0.028**	**0.0**
Never married	48 (2.4)	22 (2.3)	9 (1.9)	13 (2.6)		26 (2.5)	13 (2.5)	13 (2.61)		

In couple	729 (36.7)	332 (34.4)	170 (36.3)	162 (32.6)		397 (3.9)	211 (40.3)	186 (37.4)		
Widowed	1079 (54.3)	555 (57.5)	263 (56.1)	292 (58.8)		524 (51.3)	274 (52.3)	250 (50.2)		
Divorced/Separated	132 (6.64)	57 (5.9)	27 (5.8)	30 (6.0)		75 (7.3)	26 (5.0)	49 (9.8)		
Missing data	*2*	*1*	*0*	*1*		*1*	*1*	*0*		
Primary education, n (%)	622 (31.3)	299 (31.0)	116 (24.7)	183 (36.8)	**<0.001**	323 (31.6)	95 (18.1)	228 (45.8)	**<0.001**	0.75
Missing data	*2*	*1*	*0*	*1*		*1*	*1*	*0*		
Previous occupation, n (%)					**<0.001**				**<0.001**	**0.0**
Employee/Government employee	363 (18.7)	164 (17.6)	54 (11.8)	110 (23.1)		199 (19.6)	52 (10.0)	147 (29.8)		
Craftsman/storekeeper	499 (25.6)	220 (23.6)	81 (17.8)	139 (29.2)		279 (27.5)	92 (17.7)	187 (37.9)		
Farmer/Breeder/Fisherman	979 (50.3)	482 (51.7)	302 (66.2)	180 (37.8)		497 (49.0)	360 (69.2)	137 (27.7)		
Jobless	105 (5.4)	66 (7.1)	19 (4.2)	47 (9.9)		39 (3.9)	16 (3.1)	23 (4.7)		
Missing data	*44*	*35*	*13*	*22*		*9*	*5*	*4*		
Cardiovascular risk factors										
Tobacco use status, n (%)					**<0.001**				**<0.001**	**<0.**
Non-user	1412 (71.2)	585 (60.6)	245 (52.2)	340 (68.4)		827 (81.3)	417 (80.0)	410 (82.7)		
Ex-user	132 (6.7)	73 (7.6)	44 (9.4)	29 (5.8)		59 (5.8)	22 (4.2)	37 (7.5)		

Current smoker	118 (6.0)	52 (5.4)	44 (9.4)	8 (1.6)		66 (6.5)	50 (9.6)	16 (3.2)		
Other mode of consumption	321 (16.2)	256 (26.5)	136 (29.00)	120 (24.1)		65 (6.4)	32 (6.1)	33 (6.7)		
Missing data	*7*	*1*	*0*	*1*		*6*	*4*	*2*		
Physical activity, n (%)	553 (28.0)	369 (38.5)	209 (45.0)	160 (32.4)	<**0.001**	184 (18.1)	116 (22.3)	68 (13.7)	<**0.001**	
Missing data	*14*	*8*	*4*	*4*		*6*	*5*	*1*		
Hypercholesterolemia, n (%)	173 (10.5)	80 (9.7)	9 (2.3)	71 (16.3)	<**0.001**	93 (11.2)	13 (3.1)	80 (19.6)	<**0.001**	0.3
Missing data	*335*	*144*	*83*	*61*		*191*	*101*	*90*		
Diabetes, n (%)	158 (8.1)	42 (4.4)	19 (4.2)	23 (4.7)	0.679	116 (11.5)	55 (10.6)	61 (12.5)	0.345	<**0.**
Missing data	*36*									
BMI, median (IQR)	20.1 (5.4)	19.7 (4.8)	18.6 (4.2)	20.6 (5.3)	<**0.001**	20.4 (5.7)	19.3 (4.4)	22.3 (6.4)	<**0.001**	<**0.**
Missing data	*102*	*40*	*12*	*28*		*62*	*25*	*37*		
Nutritional variables										
Number of daily meals, n (%)					<**0.001**				0.312	<**0.**
1	389 (19.6)	314 (32.6)	117 (25.2)	197 (39.6)		75 (7.4)	43 (8.3)	32 (6.4)		
2	1061 (53.6)	386 (40.1)	196 (42.2)	190 (38.2)		675 (66.2)	349 (67.0)	326 (65.5)		
3+	531 (26.8)	262 (27.2)	152 (32.7)	110 (22.1)		269 (26.4)	129 (24.8)	140 (28.1)		
Missing data	*9*	*5*	*4*	*1*		*4*	*4*	*0*		

Alcohol consumption, n (%)					**0.008**				**0.005**	**0.0**
Abstainers	1371 (69.4)	660 (68.9)	298 (64.6)	362 (72.8)		711 (69.9)	382 (73.5)	329 (66.2)		
Light	562 (28.5)	286 (29.9)	154 (33.4)	132 (26.6)		276 (27.1)	119 (22.9)	157 (31.6)		
Moderate-to-heavy	42 (2.1)	12 (1.3)	9 (2.0)	3 (0.6)		30 (3.0)	19 (3.7)	11 (2.2)		
Missing data	*15*	*9*	*8*	*1*		*6*	*5*	*1*		
Blood pressure (mmHg), median (IQR)										
Diastolic	80.0 (20.0)	80.0 (15.0)	77.5 (12.5)	80.0 (15.0)	<**0.001**	80.0 (20.5)	80.0 (22.5)	80.0 (20.0)	0.121	<**0.**
Missing data	*7*	*2*	*0*	*2*		*5*	*1*	*4*		
Systolic	140.0 (37.5)	135.0 (35.0)	132.5 (30.0)	137.5 (30.0)	**0.003**	142.5 (37.5)	141.3 (40.0)	142.5 (40.0)	0.516	<**0.**
Missing data	*6*	*1*	*0*	*1*		*5*	*1*	*4*		
Hypertension, n (%)	1215 (61.1)	519 (53.7)	228 (48.6)	291 (58.4)	**0.002**	696 (68.0)	343 (65.3)	353 (70.9)	0.057	<**0.**

CAR: Central African Republic; IQR: Interquartile interval; ROC: Republic of Congo; SD: standard deviation; vs: versus

Table 2. Factors associated with hypertension, EPIDEMCA, 2011-2012 (n=1512)

	Multivariate analysis		
Univariate analysis	**Model 1**	**Model 2**	**Model 3**

	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p
Sex		**0.003**		0.109		0.954		0.924
Males	1		1		1		1	
Females	1.39 (1.1-1.71)		1.29 (0.94-1.77)		1.01 (0.73-1.40)		0.98 (0.70-1.37)	
Age (years)	1.03 (1.01-1.04)	**0.003**	1.02 (1.00-1.04)	**0.023**	1.02 (1.01-1.04)	**0.010**	1.02 (1.01-1.04)	**0.012**
Country		**<0.001**		**<0.001**		**<0.001**		**<0.001**
Central African Republic	1		1		1		1	
Republic of Congo	1.88 (1.53-2.32)		1.92 (1.55-2.38)		1.64 (1.30-2.07)		1.68 (1.31-2.16)	
Area		**0.00**		**0.016**		0.913		0.528
Rural	1		1		1		1	
Urban	1.32 (1.07-1.63)		1.33 (1.06-1.69)		1.01 (0.79-1.30)		1.09 (0.84-1.40)	
Marital status		0.104		0.460		0.524		0.548
Single	1		1		1		1	
Living in couple	1.03 (0.54-1.96)		1.19 (0.61-2.33)		1.12 (0.56-2.24)		1.16 (0.58-2.34)	
Widow	1.28 (0.67-2.43)		1.23 (0.63-2.40)		1.24 (0.62-2.46)		1.27 (0.63-2.54)	
Divorced/separated	0.85 (0.41-1.79)		0.87 (0.41-1.87)		0.90 (0.41-1.97)		0.92 (0.42-2.03)	
Primary education		0.443		0.341		0.331		0.566

No	1		1		1		1	
Yes	0.92 (0.73-1.14)		1.14 (0.87-1.51)		1.14 (0.85-1.52)		1.09 (0.81-1.46)	
Previous occupation		**0.020**		0.178		0.059		**0.046**
Employee/Government employee	1		1		1		1	
Craftsman/storekeeper	1.58 (1.15-2.)		1.40 (0.98-2.01)		1.56 (1.08-2.26)		1.59 (1.10-2.31)	
Farmer/Breeder/Fisherman	1.327 (0.97-1.68)		1.23 (0.86-1.75)		1.56 (1.07-2.26)		1.65 (1.13-2.41)	
Jobless	1.76 (1.04-2.97)		1.65 (0.95-2.90)		1.87 (1.05-3.32)		1.83 (1.03-3.28)	
Tobacco use status		**<0.001**				**0.034**		**0.049**
Non-user	1		-		1		**1**	
Ex-user	0.59 (0.38-0.90)		-		0.66 (0.42-1.04)		0.65 (0.41-1.03)	
Current smoker	0.43 (0.28-0.6)		-		0.60 (0.38-0.94)		0.60 (0.38-0.95)	
Other mode of consumption	0.56 (0.42-0.74)		-		0.78 (0.58-1.06)		0.81 (0.60-1.11)	
BMI (kg/m^2)	1.11 (1.08-1.14)	**<0.001**	-		1.10 (1.06-1.13)	**<0.001**	1.09 (1.06-1.12)	**<0.001**
Physical activity		**<0.001**	-			**0.031**		**0.023**
<150 min/wk	1		-		1		1	
≥150 min/wk	0.58 (0.46-0.72)		-		0.77 (0.60-0.98)		0.75 (0.59-0.96)	
High cholesterol		**0.001**	-			0.160		0.157

No	1		-	1	1	
Yes	1.78 (1.2-2.55)		-	1.32 (0.90-1.96)	1.33 (0.90-1.97)	
Diabetes		0.411	-		0.502	0.408
No	1		-	1	1	
Yes	1.17 (0.80-1.71)		-	0.87 (0.58-1.31)	0.85 (0.56-1.28)	
Number of meals		**<0.001**	-	-		**<0.001**
1	1		-	-	1	
2	1.35 (1.03-1.76)		-	-	0.98 (0.72-1.33)	
3+	2.29 (1.67-3.13)		-	-	1.85 (1.31-2.59)	
Alcohol consumption		0.094				0.953
Abstainers	1		-	-	1	
Light	0.80 (0.64-1.00)		-	-	0.99 (0.77-1.27)	
Moderate-to-heavy	0.68 (0.34-1.38)		-	-	0.89 (0.42-1.89)	

Table 3. Association* between different proxies of fat mass and hypertension, EPIDEMCA, 2011-2012

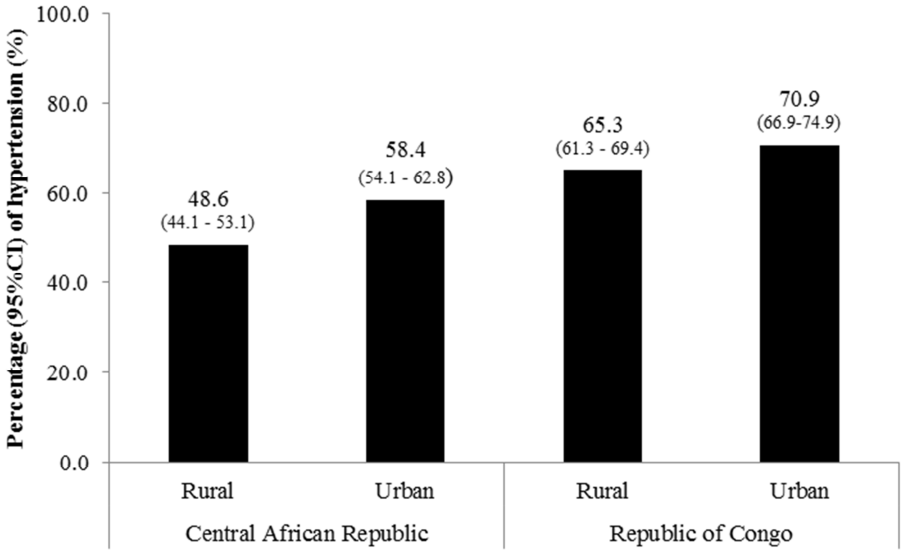
	n	OR* (95%CI)	p
lnMUAC (cm)	1532	9.96 (4.38-22.68)	**<0.001**
TCT (mm)	1521	1.06 (1.03-1.08)	**<0.001**
Abdominal obesity	1497	1.25 (0.99-1.56)	**0.057**

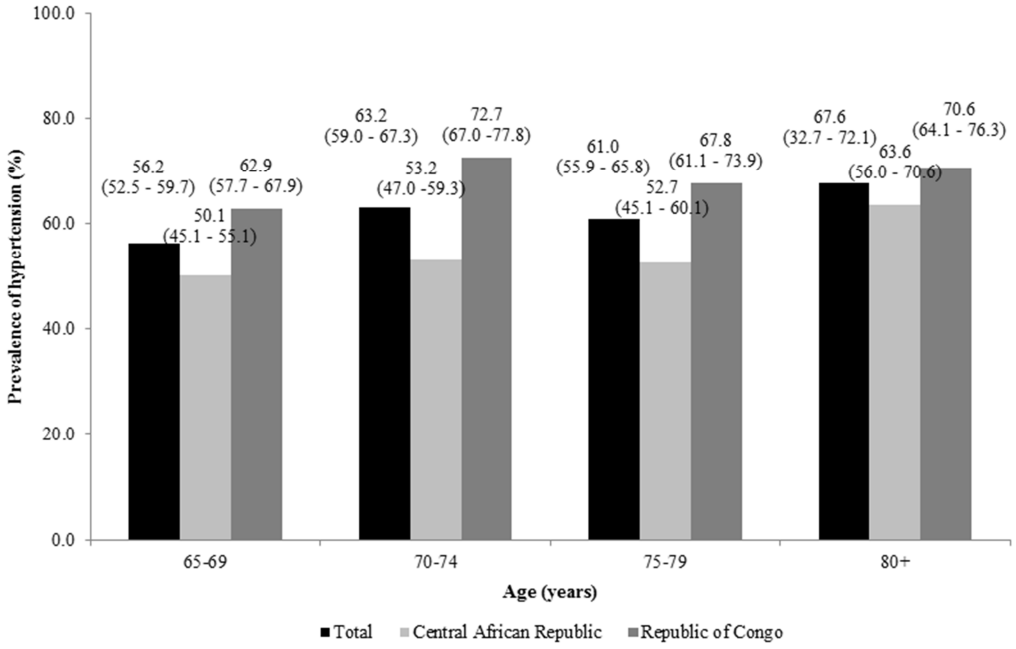
* adjusted for sex, age, country, area, marital status, primary education, previous occupation, tobacco use status, physical activity, high blood cholesterol level, diabetes, number of daily meals and alcohol consumption.

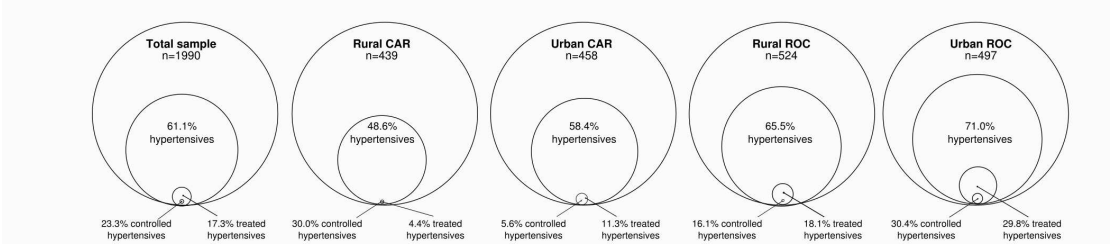
Table 4. Factors associated with awareness, treatment and controlled hypertension, EPIDEMCA, 2011-2012

	Awareness		**Treatment**		**Controlled hypertension**	
	OR (95%IC)	**p**	**OR (95%IC)**	**p**	**OR (95%IC)**	**p**
Sample size	1214		1215		206	
Age		0.005		0.024		0.026
65-69	1		1		1	
70-74	0.72 (0.53-0.98)		0.64 (0.43-0.96)		0.65 (0.29-1.46)	
75 +	0.63 (0.47-0.40)		0.63 (0.44-0.91)		0.30 (0.12-0.72)	
Sex		0.009		0.478		0.213
Male	1		1		1	
Female	1.45 (1.10-1.92)		0.88 (0.61-1.26)		0.63 (0.29-1.35)	
Primary education		0.048		0.163		0.516
No	1		1		1	
Yes	1.36 (1.00-1.84)		1.31 (0.90-1.92)		0.77 (0.34-1.71)	
Country		<0.001		<0.001		0.146
Central African	1		1		1	

Republic						
Republic of Congo	2.59 (2.04-3.30)		3.78 (2.63-5.44)		1.94 (0.79-4.74)	
Area		0.018		<0.001		0.144
Rural	1		1		1	
Urban	1.35 (1.05-1.72)		1.90 (1.36-2.67)		1.79 (0.82-3.92)	







Highlights

- Hypertension is highly prevalent in adults over age of 65 in Central Africa.
- The awareness, treatment and control of hypertension are low.
- The prevalence differs between 2 neighboring countries and within countries.
- Actions for controlling hypertension in the elderly must be taken in this region.